Letter from Alexander Graham Bell to Mabel Hubbard Bell, June 19, 1911, with transcript

Beinn Bhreagh, near Baddeck, Nova Scotia. June 19, 1911. Mrs. Alexander Graham Bell, 1331 Conn. Ave., N. W., Washington, D. C. Dear Mabel:

In walking down to the Houseboat Saturday evening, I saw a partridge on the road at some distance away acting in a queer manner. You have noticed how a peacock, when he exhibits his tail and struts proudly about, scrapes the ground with the tips of his wings making quite a curious drum-like sound. This is what my little partridge friend was doing so I stopped to watch him. He did not seem at all afraid although I was only about 50 feet away. He soon gave up strumming or drumming and went into the bushes on the side of the road. The moment, however, I advanced, the partridge was in the road again and actually came forward to attack me drumming with his wings — I think I better say — her wings — and clucking. Every time I advanced she made a rush towards me and actually came within 3 feet drumming and clucking to drive me away. She evidently had a nest near there. I could not see it from the road and did not care to disturb her further by searching for it.

I had a beautiful time at the houseboat carrying on salt water experiments and devising a method for the classification of my sheep.

I have been much struck by the curious change of 2 temperature at different depths in salt water containing floating ice; and wondered whether the same effect might not occur in fresh water. My knowledge of temperature conditions in fresh water is mere book knowledge and I thought it might be well to test the distribution of temperature experimentally.

I filled up a large glass jar,having a diameter of 25 cm, with fresh water from the tap to a depth of 9 cm. After some time I found the temperature at the bottom to be 8°.75 C. This was at a depth of 9 cm. The temperature remained at 8°.75 as I raised the thermometer till I came near the surface. At a depth of 2 cm, the thermometer registered 9°, and at the surface 9°.37. Thus, the whole body of fresh water had practically the same temperature.

I then put in a quantity of ice raising the level of the water to 14 cm. Temperature at bottom 4°.00. This continued without much change as the thermometer was raised from the bottom (14 cm down) up to the 8 cm level where it was 3°.50. From this point up the temperature fell very speedily to zero 0° and at the surface was only+°.50. This is just what I expected; and only verifies the book knowledge of the subject.

I made similar experiments with a saturated solution of salt. On Saturday evening (June 17) I heated up some of the salt water employed in previous experiments until the solution began to deposit salt, so as to be sure that I had a really saturated solution. The salt crystals formed on the surface. They seemed to be square and hollowed in the middle, floating like little square saucers on the water; 3 then they would become water-logged and sink to the bottom. At one time it looked as though the crystals on the surface were united to form a film like young ice on fresh water; but after a while water came up from below through a hole in the film and the whole skin of salt sank to the bottom. Then a new skin appeared and the process was repeated. Having watched several successive skins form and fall, I poured out the liquid brine into a jar to cool leaving the solid salt behind. I felt sure that at last I had a really saturated solution.

Yesterday (June 18) I made experiments with this brine. I filled up my glass jar to a depth of 9 cm filtering the brine first through a dishcloth to make sure that there were no solid particles in it.

The temperature at the bottom was 15°.50 and at the top 15°.25. I find it was the reverse. 15°.50 at the top and 15°.25 at the bottom. From a depth of 4 to 7 cm the temperature was

15°.12. Thus the temperature was substantially uniform at all depths but slightly warmer at the top and bottom than in the middle. The difference, however, was only a fraction of a degree; and the fact that such a difference could be observed with confidence is due to the delicacy of the thermometer and to the fact that the figures represent the mean of more than one set of observations.

I think we may conclude that salt water, like fresh water, without any ice in it, has substantially the same temperature at all depths.

I then put in a lot of ice raising the level of the brine to 15 cm. The following table shows the resulting 4 temperatures at different depths. The figures are the means obtained from four series of observations:

Ice Floating in Clear Brine

Depth Temp.

0 cm - 1°.93

1 cm - 3°.68

2 cm - 4°.06

3 cm - 3°.56

4 v cm - 2°.93

5 cm - 2°.06

6 cm - 0°.25

7 cm + 1°.43

8 cm + 3°.93

9 cm + 5°.82

10 cm + 7°.56

11 cm + 9°.00

12 cm + 9°.62

13 cm + 10°.00

14 cm + 10°.31

15 cm + 10°.93

I am now perfectly satisfied in my own mind or rather I am perfectly satisfied that ice floating in clear brine, without any undisolved salt in it, and without any salt sprinkled upon the ice, reduces the temperature of the brine to a point several degrees below zero Centigrade.

In the above experiment the lowest temperature (-4°.06 C) was produced at a depth of only 2 cm from the surface. Below this point the temperature gradually rose all the way down to the bottom where the thermometer registered +10°.93 C. Above the depth of 2 cm the thermometer also rose 5 to a slight degree, but even at the surface it was below zero (-1°.93).

This raises in my mind the suspicion that brine contracts in warming, at least as far as the temperature of 11° C; whereas fresh water expands when it is heated beyond +4°C. Starting at 0°C, the freezing point of fresh water, the water contracts as it is heated, becoming denser and heavier, until the temperature of +4°C is reached. Then, as the heating process is continued, the water expands again becoming specifically lighter as the temperature is increased. Thus the temperature of 4°C represents the temperature of maximum density in fresh water.

The case seems different with brine. The effects produced in the experiment noted above seemed to indicate that in the case of brine the water goes on contracting, and becoming heavier and denser as it is heated above 4°C, at least as far as 11°C (which is practically the same thing as 10°.93, the bottom temperature in the above experiments. How much further the contraction would go with heating could only be shown by taking the bottom temperature in deeper vessels than that used.

The experiment suggests that, in order to reduce the temperature of a deep mass of salt water below zero , it might be advisable to keep the ice at the bottom of the water instead of the top. This also would pro b ably produce a lower temperature at the surface because the fresh water produced by the melting of the ice would become salt before it reached the surface. I presume that the fact that the brine is warmer 6 at the surface than at a depth of 2 cm below results from the freshness of the water there. The fresh water produced by the melting of the ice floats on the surface. If you could add salt to the water at the surface it would probably acquire a lower temperature.

This indeed seems to be shown by another experiment in continuation of that noted above. I put plenty of salt on the ice floating in the clear brine. The following table shows the result upon the temperature at different depths. Compare with table above:

Salt on Ice Floating in Brine

Depth Tempt

0 cm -3°.50

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7 cm +1°.12

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9 cm m-

10 cm +4°.75

11 cm -

12 cm +5°.87

13 cm -

14 cm +6°.50

15 cm -

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The following is a brief summary of the result obtained.

SUMMARY

1. Ice, sprinkled with salt, produces in the water in which it floats a temperature below zero Centigrade.

2. Salt, in the solid state, is not necessary to the effect. Ice floating in clear brine produces a minus temperature in the brine.

3. Ice, of course, is fresh water in a solid condition. The solid condition seems to be necessary to the effect. A layer of fresh water at zero temperature, floating upon brine does not produce a minus temperature.

4. The presence of salt, either in the liquid or solid condition, seems to be necessary to the effect. Ice floated in fresh water does not reduce the temperature below zero Centigrade.

5. In order to ascertain whether the effect was due to the presence of salt specifically, and not simply due to an increase in the specific gravity of the water by holding a salt of some kind in solution, I tried sugar in solution instead of salt. Ice, floated in a strong solution of sugar in water did not produce a minus temperature. It looks as though the effect was due to the presence of salt specifically 8 (chloride of sodium) acting upon ice (fresh water in the solid condition.

I have lots more to write about in the way of experiments and researches but this letter is already long enough; and I am afraid that too much salt water might act as an emetic.

Took this letter back with me to the Hall hoping to add a P.S. but Manchester has just come in to dinner and to go over financial matters.

Won't make definite arrangements with him until you come — if you don't wait too long. Like the idea of asking Brynes to take the Farm Dept. as a speculation. Must go now. Pansy Lodge is great as an office.

Your loving Alec.

ALEXANDER GRAHAM BELL TO MABEL (Hubbard) BELL Beinn Bhreagh, C. B. June 19th, 1911. Mrs. Alexander Graham Bell, 1331 Connecticut Avenue, N. W. Washington, D. C. Dear Mabel:

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